VIRGINIA AGRICULTURAL COUNCIL PREPROPOSAL FORM

Title: Integrated Approaches for Reducing Synthetic Fertilizer Inputs in Apple Orchards

Objectives: (1) To reduce the amount of synthetic nitrogen fertilizer applied to apple orchards in Virginia.
(2) To identify newly released apple rootstock germplasm for their nitrogen utilization efficiency.
(3) To use molecular techniques to describe the soil biota that develops in more efficient and sustainable apple orchard agroecosystems.

Approach: In 2013, a pot-in-pot study was implemented to determine the effects of different composts (yard waste and chicken litter), calcium nitrate fertilizer, and combinations of compost and calcium nitrate fertilizer on apple tree growth and nutrient status, soil health and microbial activity. Since soil conditions are often slow to change, fertilizer studies, particularly those that include composts, can sometimes take years to yield satisfactory data. The pot-in-pot system allows us to more rapidly screen fertilizer and, in this case, apple rootstock treatments.

An equivalent rate of nitrogen (35.7 pounds per acre) was applied in five different fertilizer treatments: (1) chicken litter compost, (2) municipal compost, (3) calcium nitrate, (4) a combination of chicken litter compost and calcium nitrate at equal rates of nitrogen, and (5) a combination of municipal compost and calcium nitrate at equal rates of nitrogen, plus an unfertilized control was applied to five different apple rootstocks ('Budagovsky 9', 'Malling 9', 'Geneva 41', 'Geneva 214', and 'Geneva 935'). All of the rootstocks were top-grafted with 'Gala'. Orchard soil was used to reflect conditions in a commercial operation. Each of these 30 treatment combinations was replicated four times in a completely randomized design. During the growing season, the pots were watered twice weekly with a micro-sprinkler system. All other cultural and pest management was uniformly performed on the trees.

We will measure tree growth (trunk cross-sectional area), soil nutrients, leaf nutrients, microbial respiration, and changes in microbial communities determined by molecular techniques. Soil microbial communities can be highly variable, and can have both positive and negative effects on orchard productivity and/or fruit quality. There is little agreement among studies pointing to mechanisms supporting positive or negative results; however, evidence suggests that when available, incorporation of organic fertilizers often support crop growth through a reduction in microbial pathogens in addition to enhanced nutrient availability. It is therefore a ***major objective*** of the research in this proposal to understand how inorganic and organic fertilizers impact microbial communities, soil organic matter pools, and support the productivity and growth of orchard agroecosystems.

Justification: By developing integrated approaches to orchard fertility management, our project seeks to increase soil quality, lessen the use of synthetic fertilizers, and increase orchard productivity—all of which are characteristics of a sustainable agricultural system. Additionally, as the cost of synthetic fertilizers have dramatically

increased in recent years the results of the proposed project have the potential to reduce the cost of production for apple growers, making the proposed integrated approach to soil fertility a question of both environmental and economic sustainability.

Gaining a better understanding of soil quality and soil fertility is of great interest to commercial tree-fruit growers in the Commonwealth. In a 2011 research-needs survey of commercial apple growers in Virginia, 90% of the 74 respondents considered "improving management of nutrients requirements in Virginia orchards" to be either an "important" or "very important" area for future research. Similarly, 88% of the respondents considered "improving soil quality in the orchard" to be an "important" or "very important" area of research; and, 78% of respondents considered the "evaluation of potential environmental impacts from the orchard operation (including nutrient leaching)" to be "important" or "very important".

Soil fertility management practices and rootstock genotype impact soil health and nutrient status, plant associated soil microbial communities, and tree growth and fruit yield. Growers select specific apple rootstocks for use in their orchard systems to confer beneficial traits, including size control, precocity, and pest and disease resistance. Rootstock genotypes confer some of these traits through interactions with the soil microbiome. Such interactions may alter soil microbial community structure, resulting in changes to tree growth and yield. Nitrogen fertilizers may improve fruit yield and quality. However, applying an excessive amount of nitrogen fertilizers may reduce crop yield and quality, and may cause environmental problems such as the contamination of ground and surface waters. The addition of carbon-based amendments, such as compost, have been shown to reduce nitrogen and water loss, while improving soil structure and making certain mineral nutrients more available to plants and microorganisms.

Funding from the VAC is being sought to support doctoral candidate Ashley Thompson so she may complete the work on this project. Previously, Ms. Thompson was funded with funds provided to Dr. Peck for initiating his research program in Winchester.

Include a brief explanation of the Economic impact the project would have on Virginia agriculture. Profitability for high-density orchards is largely dependent on obtaining sufficient vegetative growth and high fruit yields during the first three years after planting, a goal typically achieved through applying high rates of synthetically derived nitrogen fertilizer. However, there is little scientific evidence to support a specific fertilizer formulation, timing, or rate in these newly planted commercial apple orchards. Developing management practices and recommendations for the most sustainable management practices will support growers economically, through more efficient fertilizer application, and ecologically, by developing healthier soils with increased microbial abundance and diversity. Additionally, by optimizing nitrogen fertilizer applications, external costs to society at large will be reduced. Recently developed partial budget worksheets for apple orchards will be used to analyze the economic costs and benefits from changing fertilization practices.

VIRGINIA AGRICULTURAL COUNCIL PREPROPOSAL FORM

INVESTIGATOR(S)*__Gregory Peck, Ph.D. _____
DURATION (years) one__X__two_____
BUDGET (yr. one) __$21, 683_____(total)_____
***<u>One</u> pre-proposal per PI please**

COMMODITY GROUPS	**CHECK *<u>ONE</u>* GROUP THAT BEST DESCRIBES YOUR PROJECT**
Aquaculture	
Fruit/Wine	**X**
Livestock Dairy Poultry Hogs Beef Sheep Goats Horses	
Nursery/ Forestry	
Row Crops	
Turf/Seed	
Vegetable	
Educational	
Miscellaneous Agriculture	